Proc. Natl. Acad. Sci. USA 78:1527, 1981); gpt, which confers resistance to mycophenolic acid (Mulligan and Berg, *Proc. Natl. Acad. Sci. USA* 78:2072, 1981); neo, which confers resistance to the aminoglycoside G-418 (Colberre-Garapin *et al.*, *J. Mol. Biol.* 150:1, 1981); and hygro, which confers resistance to hygromycin (Santerre *et al.*, *Gene* 30:147, 1984).

Alternatively, any GLUTX-containing fusion proteins can be readily purified utilizing an antibody specific for the fusion protein being expressed. For example, a system described by Janknecht *et al.* allows for the ready purification of non-denatured fusion proteins expressed in human cell lines (*Proc. Natl. Acad. Sci. USA* 88:8972-8976, 1991). In this system, the gene of interest is subcloned into a vaccinia recombination plasmid such that the gene's open reading frame is translationally fused to an amino-terminal tag consisting of six histidine residues. Extracts from cells infected with recombinant vaccinia virus are loaded onto Ni^{2+}.nitriloacetic acid-agarose columns and histidine-tagged proteins are selectively eluted with imidazole-containing buffers.

As implied by the descriptions above, a host cell is any cell into which (or into an ancestor of which) a nucleic acid encoding a polypeptide of the invention (*e.g.*, a GLUTX polypeptide) has been introduced by means of recombinant DNA techniques.

II. GLUTX Polypeptides

The GLUTX polypeptides described herein are those encoded by any of the nucleic acid molecules described above, and include fragments of GLUTX, mutant forms of GLUTX, active and non-active allelic variants of GLUTX, splice variants of GLUTX, truncated forms of GLUTX, and

fusion proteins containing all or a portion of GLUTX. These polypeptides can be prepared for a variety of uses including, but not limited to, the generation of antibodies, as reagents in diagnostic assays, for the identification of other cellular gene products or exogenous compounds that can modulate the activity or expression of GLUTX, and as pharmaceutical reagents useful for the treatment of any disorder in which the associated symptoms are improved by altering the activity of GLUTX.

The terms "protein" and "polypeptide" are used herein to describe any chain of amino acid residues, regardless of length or post-translational modification (*e.g.*, modification by glycosylation or phosphorylation). Thus, the term "GLUTX polypeptide" includes full-length, naturally occurring GLUTX polypeptides (that can be purified from tissues in which they are naturally expressed, according to standard biochemical methods of purification), as well as recombinantly or synthetically produced polypeptides that correspond either to a full-length, naturally-occurring GLUTX polypeptide or to particular domains or portions of such a polypeptide. The term also encompasses mature GLUTX having an added amino-terminal methionine (useful for expression in prokaryotic cells).

Preferred polypeptides are substantially pure GLUTX polypeptides that are at least 50% (*e.g.*, 55%, 60%, or 65%), more preferably at least 70% (*e.g.*, 72%, 75%, or 78%), even more preferably at least 80% (*e.g.*, 80%, 85% or 90%), and most preferably at least 95% (*e.g.*, 97% or even 99%) identical to the sequences encoded by SEQ ID NO:1 (*e.g.*, SEQ ID NO:2). Those of ordinary skill in the art are well able to determine the percent identity between two amino acid sequences. Thus, if a polypeptide is encoded by a nucleic acid that hybridizes under stringent conditions with the

GLUTX cDNA sequence disclosed herein and also encodes one or more of the conserved regions present in GLUTX, it will be recognized as a GLUTX polypeptide and thereby considered within the scope of the present invention.

The invention also encompasses polypeptides that are functionally equivalent to GLUTX. These polypeptides are equivalent to GLUTX in that they are capable of carrying out one or more of the functions of GLUTX in a biological system. Polypeptides that are functionally equivalent to GLUTX can have 20%, 40%, 50%, 75%, 80%, or even 90% of one or more of the biological activities of the full-length, mature human form of GLUTX. Such comparisons are generally based on an assay of biological activity in which equal concentrations of the polypeptides are used and compared. The comparison can also be based on the amount of the polypeptide required to reach 50% of the maximal biological activity obtainable.

Functionally equivalent proteins can be those, for example, that contain additional or substituted amino acid residues. Substitutions may be made on the basis of similarity in polarity, charge, solubility, hydrophobicity, hydrophilicity, and/or the amphipathic nature of the residues involved. Amino acids that are typically considered to provide a conservative substitution for one another are specified in the Summary of the Invention.

Polypeptides that are functionally equivalent to GLUTX can be made using random mutagenesis techniques well known to those of ordinary skill in the art (and the resulting mutant GLUTX polypeptides can be tested for activity). It is more likely, however, that such polypeptides will be generated by site-directed mutagenesis (again using techniques well known to persons of ordinary skill in the art). These polypeptides may have increased